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UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

SAN JOSE DIVISION

SENSOR ELECTRONIC TECHNOLOGY, INC., a New York Corporation Plaintiff, vs. BOLB, INC., a Delaware Corporation, QUANTUM EGG, INC., a Delaware Corporation Defendant.	Case No.: 5:18-cv-05194-LHK **DECLARATION OF PROFESSOR STEVEN DENBAARS** Complaint Filed: August 24, 2018

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DECLARATION OF PROFESSOR STEVEN DENBAARS

I, Professor Steven DenBaars, hereby declare the following:

1. I am over the age of 18 and have personal knowledge of the matters stated herein. I could truthfully testify thereto if called upon as a witness.

2. I have been retained by Plaintiff Sensor Electronic Technology, Inc. ("SETi" or "Plaintiff") to provide testimony and opinions regarding light emitting diode (LED) technology. In particular, I have been asked to provide a summary of my knowledge regarding certain technical terms at issue for purposes of claim construction in this case.

3. I will first provide a summary of my relevant background and experience. Then I will summarize my relevant conclusions.

4. I am a Professor at the University of California, Santa Barbara in the Engineering Department. My current title is the Mitsubishi Distinguished Professor of Materials and Electrical & Computer Engineering.

5. I received a Bachelors of Science in Materials and Metallurgical Engineering from the University of Arizona in 1984 and was the valedictorian of my graduating class. I then received a Masters in Science in Materials Science in 1986 from the University of Southern California. I completed my formal education in 1988 when I received a Doctorate in Electrical Engineering from the University of Southern California.

6. Following three years in industry performing research at Hewlett-Packard I began my teaching career in 1991 as an Assistant Professor at the University of California, Santa Barbara. I became a full professor in 1998 and retain that position today. In addition, starting in 2002 I became the Executive Director of the Solid State Lighting and Display Center at the University of California, Santa Barbara, which evolved into the the Solid State Lighting and Energy Center.

7. During the course of my career I have received a number of awards and recognitions. In 1994 I was a recipient of the National Scientist Foundation Young

Investigator Award. In 2005 I received the Fellow Award from the Institute of Electrical and Electronics Engineering (IEEE). In 2010 I received the Aron Kressel Award from the Institute of Electrical and Electronics Engineers (IEEE) Photonics Society for "pioneering work in the development of high-efficiency nonpolar and semipolar nitride-based materials and devices for solid state lighting." And most recently, in 2014 I became a Fellow of the National Academy of Inventors.

8. I have been an author on more than 800 publications and a named inventor on more than 500 patents and patent applications worldwide on behalf of the University of California.

9. Over the course of my thirty-year career, my research has focused on the growth and properties of wide bandgap semiconductors. Gallium nitride (GaN), a wide bandgap semiconductor prized for its ability to generate blue light, has become a foundation of modern LED-based lighting.

10. Over the course of my career, the LED industry has been characterized by a relentless pursuit of efficiency improvements. In this context, efficiency refers to the ability to wring every more usable light out of the same amount of electrical power.

11. In the LED field we generally discuss two forms of efficiency losses: internal quantum efficiency, *i.e.*, the recombination of an electron (negative charge carrier) and a hole (positive charge carrier) to produce a photon (usable light); and external quantum efficiency, *i.e.*, the portion of the generated photons that escape from the LED.

12. One of the structural difficulties that cause internal quantum efficiency losses are defects in the crystal structure of the active (light producing) layer of an LED. The defects, which come in a number of different forms, are locations where, for example, recombination can occur without producing a usable photon. Although defects can occur in any layer of a semiconductor device, some types of defects (*e.g.*, dislocations) do no occur only in a single layer, but instead can result in the vertical

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growth of that same defect throughout each layer the resulting crystal. These defects can result, for example, when the crystal lattice of the material being grown differs from that of the underlying growth substrate. For example, gallium nitride (GaN) is often grown on sapphire (Al_2O_3) despite a significant lattice mismatch between those materials.

13. Among the many known tools for minimizing the number of dislocation defects that reach the active layer was a dislocating blocking structure, which was (and still is) also known as a dislocation blocking layer.

14. At or around the time of filing U.S. Patent No. 9,966,496 ("the '496 patent") in 2013, a person having ordinary skill in the art would have understood the term dislocation blocking structure to refer to a small set of known epitaxially grown semiconductor layers. The '496 patent discusses a number of those structures. More specifically, the major source of dislocations during the growth of a semiconductor crystal is the stress caused by the mismatch between the crystal being grown and the underlying crystalline substrate. The growing crystal naturally relieves some of that stress by incorporating dislocation defects in its crystal lattice.

15. I am aware of at least 3 different semiconductor structures that would have been considered dislocation blocking structures at the relevant time.

16. A first type of dislocation blocking structure used multiple semiconductor layers have different compositions to control the stresses within the layer and thereby block the growth of dislocations. More specifically, by creating layers in series that expert compressive and tensile stresses upon each other, the stress-caused dislocations can be controlled.

17. A second type of dislocation blocking structure used a non-planar growth surface (for example patterning) to control dislocations. More specifically, instead of relying solely on the flawed dislocation-containing growth surface to control the growth of the overlying crystal, patterning the underlying layer can permit the growth of a subsequent layer having fewer dislocations.

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18. A third type of dislocation blocking structure employed relaxation as part of the growth process. During relaxation, instead of changing the composition or shape of the growth surface, the growth conditions are altered to effectively allow the growing crystal to heal its own dislocations as subsequent layers of crystal are formed.

Dated: May 9, 2019

Steve DenB

Prof. Steven DenBaars

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